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[Note: Names, addresses, company names and brand names are translated in the most common manner. Japanese language does not have singular or plural words unless otherwise specified by a numeral prefix or a general form of plurality suffix.]

(54) [Name of the Invention]

Coordinate Input Device

(57) [Summary]

[Problem]

The problem to be solved is to prevent an internal electric circuit from short-circuiting caused by foreign matter from the outside in an ultrasonic wave vibration type coordinate input device.

[Solution Measures]

A shield case 62 is provided in the inside of the housing 61 of the device in order to cover the vibration sensor 6a, the electrode 63, the preamplifier 401, which have been placed on the vibration transmission plate 8, and the shielding from the outside noise is achieved. The case 62 has a structure that is formed as strong magnetic material metal plating 621 is provided on the magnetized material 622 that is a magnetized strong magnetic material, and especially, it is magnetized so that a strong magnetic field is formed especially at the side edge part 62a of the case 62. In the case when the external foreign matter enters inside the housing 61 through the gap with the transmission plate 8 and especially when the foreign matter is iron etc., strongly magnetic material, through the magnetic force it is attracted to the side edge part 62a of the case 62 and the penetration inside the housing is prevented. Consequently, there is no short-circuiting of the electric circuit inside the housing through this foreign matter.

[Scope of the Claims]

[Claim 1]

Coordinate input device characterized by the fact that it is a coordinate input device that has a vibration transmission plate and a vibration detection means, which is provided on a predetermined position on the above vibration transmission plate, and a vibration that is input at any input point on the above described vibration transmission plate through a vibration input device is detected through the above described vibration detection means, and based on the vibration transmission time from the input point to the vibration detection means, the coordinates of the input point are calculated;

which has a structure where it has shield case formed from a strongly magnetic material that covers the above described vibration detection means that is place don the above described vibration transmission plate and shields from the external noise,

and where the above shielding case has at least one part that is magnetized, and in the case when foreign matter comprised of strongly magnetic material enters from the outside into the shield case, the above foreign matter is attracted through the above magnetic force and the penetration is prevented.

[Claim 2]

Coordinate input device according to the above Claim paragraph 1 characterized by the fact that the housing body of the coordinate input device covers the above described shield case and also it is positioned at a distance from the vibration transmission plate so that a gap can be formed between the above housing body and the above described vibration transmission plate,

And especially, the above described shield case also is positioned at a distance from the vibration transmission plate so that a gap can be formed between the above shield case and the above described vibration transmission plate.

[Detailed Explanation of the Invention]

[0001]

[Technology Pertinent to the Invention]

The present invention is an invention about a coordinate input device, and in more details it is an invention about a coordinate input device that detects vibrations input from any input point on a vibration transmission plate from a vibration input means through a vibration detection means that is placed on a predetermined position on the vibration transmission plate; and the coordinates of the input point are calculated based on the vibration transmission time from the above described vibration input point to the vibration detection device.

[0002]

[Previous Technology]

Regarding the coordinate input device that performs coordinate input through ultrasonic wave vibration, for example, as it has been disclosed according to the Japanese patent report Number Hei-Sei 5-62771, on the tablet (vibration transmission plate), which forms the structure of the coordinate input surface, a vibration sensor is placed, and the vibration that is input at any vibration input point on the tablet coordinate input surface is detected by the vibration sensor, and the coordinates of the input point are calculated based on the vibration transmission time from the input point to the vibration sensor. In

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the case of this method, because of the fact that it is not necessary to provide fine processing to form a matrix type etc., electric wiring on the surface of the tablet, it is possible to suggest an inexpensive cost device. However, in as the tablet a transparent plate glass is used, compared to the other methods it is possible to form the structure of a high transparency coordinate input device. When this high transparency device is used, there is the input-output one body type device that has a structure where a liquid crystal display device and an ultrasonic vibration type coordinate input device are stacked. Through this device, it is possible to perform coordinate input on the tablet relative to the display screen surface and because of that the viewing properties and the operational properties are excellent, and the application of this device in the future is anticipated.

[0003]

[Problems Solved by the Present Invention]

Figure 9 represents a schematic sectional view diagram showing the structure around the vibration sensor in the case of the above-described input – output one body type device according to the previous technology. In the same diagram, 81 represents the casing body of the device. 82 is the vibration input pen that performs the coordinate input operation and it generates ultrasonic wave motion. 83 represents the vibration transmission plate (glass plate) that forms the structure of the coordinate input surface. 84 is a vibration sensor that is provided on the edge part of the vibration transmission plate 83. 85 is an electrode use din order to connect the vibration sensor 84 to the post-processing circuit. 86 is a liquid crystal display device.

[0004]

When the tip of the vibration input pen 82 comes in contact with any input point on the coordinate input surface of the vibration transmission plate 83, by that the ultrasonic vibration motion that is generated from the pen 82 is transmitted from its input point and it is detected by the vibration sensor 84. Then, the coordinates of the input point are calculated based on the vibration transmission time from the input point to the vibration sensor 84.

[0005]

However, in the case of this device, the main principle is the calculation of the input point coordinates based on the speed of the sound and the transmission time of the ultrasonic wave motion, and because of that, based on the fact that the speed of the sound inside the vibration transmission plate 83 is constant, the waveform of the signal detected by the vibration sensor 84, usually, is preferred to have the same form. Because of that, it is preferred that in the transmission pathway of the ultrasonic wave transmission there are no other intermediaries besides the vibration transmission plate 83, and due to that as it is shown by the arrow in Figure 8, it is possible to form a gap between the housing body 81 and the vibration transmission plate 83 so that there is no interference in the vibration cased by the casing body 81 on the transmission of the vibration transmission plate 83.

[0006]

However, if this gap is opened, there is the problem that it is said that it is easy for external foreign matter to penetrate inside the housing body 81. Especially, if metal foreign matter penetrates inside the housing body 81, by that it becomes possible to case short-circuiting of the electric circuits inside the housing body 81 and to case erroneous operations of the device, lack of operations, or fire etc., issues, and thus there are problems with respect to the reliability and the safety properties of the devices.

[0007]

Here, then, the problem of the present invention is that for such type of coordinate input device, it prevents the short-circuiting of the electric circuits inside the device, which is caused by foreign matter penetrating from the outside, and it improves the reliability and the safety properties of the device.

[0008]

[Measures in Order to Solve the Problem]

In order to solve the above described problems, according to the present invention, it has a structure where it is a coordinate input device that has a vibration transmission plate and a vibration detection means, which is provided on a predetermined position on the above vibration transmission plate, and a vibration that is input at any input point on the above described vibration transmission plate through a vibration input device is detected through the above described vibration detection means, and based on the vibration transmission time from the input point to the vibration detection means, the coordinates of the input point are calculated; which has a structure where it has shield case formed from a strongly magnetic material that covers the above described vibration detection means that is place don the above described vibration transmission plate and shields from the external noise, and where the above shielding case has at least one part that is magnetized, and in the case when foreign matter comprised of strongly magnetic material enters from the outside into the shield case, the above foreign matter is attracted through the above magnetic force and the penetration is prevented.

[0009]

In the case when such structure is present, when external foreign matter penetrates inside the shield case, if this foreign matter is comprised of iron, etc., strongly magnetic material, it is attracted to the shield case by the magnetic force and the penetration of this foreign matter inside the shield case can be prevented. Consequently, this foreign matter does not cause short-circuiting of the electric circuits inside the shield case.

[0010]

Also, in order to be able to prevent this short-circuiting according to the previous method, the shield case and the housing body of the coordinate input device are positioned at a distance from the vibration transmission plate so that it is possible to open gaps between them correspondingly and the vibration transmission plate, and it is possible to not have interference in the vibration transmission of the vibration transmission plate.

[0011]

[Conditions of the Practical Implementation of the Invention]

Here below, the diagrams are used as reference and the conditions of the practical implementation of the present invention are explained.

[0012]

{Explanation of the structure of the whole body of the coordinate input device}

First, an explanation of the structure of the whole body of the practical embodiment of the coordinate input device of the present invention is provided based on   Figure 1.

[0013]

According to Figure 1, 1 represents the calculation performing control circuit, which controls the whole body of the device and together with that as it is described here below, it calculates the input point coordinates, and it transmits the signal of this coordinate data to the host computer 10 by using a serial cable, etc. The details of the calculation performing control circuit 1 are described here below.

[0014]

2 represents the pen code, through that different types of signals are transmitted from the calculation performing control circuit 1 to the pen inner part circuit 4 that is inside the vibration input pen 3. The details of the vibration input pen 3 are described here below.

[0015]

8 represents a vibration transmission plate that is formed from an acrylic or glass plate, etc., and its top surface is used as the coordinate input surface, however on its top surface, in order to prevent the scattering at the time of a breakage of the vibration transmission plate 8, a scatter prevention film comprised of PET, etc., (laminate) is stretched and adhered by using an adhesive agent. The coordinate input through the vibration input pen 3 is performed as the top surface of this vibration transmission plate is touched. In practice, the touch is performed by the vibration input pen inside the region denoted by the letter A, which is shown by the solid line in Figure 1. Also, on the outer perimeter of the vibration transmission plate 8, in order to prevent that the vibrations reflected by the outer edge surface of the vibration transmission plate 8 return to the center part (back

sensing) the anti-vibration (dampening) material 7 is provided. Then, at the four corners of the edge part of the vibration transmission plate 8, correspondingly, in the vicinity of the interface with the dampening material 7, the electric voltage elements etc., vibration sensors 6a ~ 6d, which convert mechanical vibrations into electric signals, are fixed.

[0016]

9 is the signal waveform detection circuit and it treats the vibration sensor signals that are input correspondingly by the vibration sensors 6a ~ 6d, and signals are generated that indicate the timing of the vibration propagation at each sensor, and it is output to the calculation performing control circuit 1.

[0017]

11 represents a liquid crystal display device etc., dot unit display capable display, and it is stacked on the lower surface of the vibration transmission plate 8. This display 11, through the image signals that are output by the host computer 10, displays dots at the positions of the input points that have been touched by the vibration input pen 3. This becomes possible because of the fact that the transparent vibration transmission plate 8 can be viewed through.

[0018]

(Explanation of the Vibration Input Pen)

After that, the vibration input pen 3 will be explained in details by using Figure 2. As it is shown in Figure 2, the pen internal part circuit 4, which is housed inside the vibration input pen, has a structure that is formed from the vibration seed start up circuit 41 and the vibrator 42. The vibrator 42 start up signal is supplied from the calculation performing control circuit 1 as a low level pulse signal, and through the vibration seed start up circuit 41 it is amplified at the predetermined gain, and after that it is applied to the vibrator 42. Regarding the electric start up signal, through the vibrator 42, it is converted into mechanical ultrasonic vibration, and through the touch of the pen tip of the pen 3, it is transmitted to the vibration transmission plate 8. Moreover, regarding the vibrator start up circuit 42, it is also a good option if it is not housed inside the vibration input pen 3 and it is provided on the control substrate plate on the side of the main body of the coordinate input device.

[0019]

Regarding the vibration frequency of the vibrator 42 it can be selected as a value that can generate a plate wave in the vibration transmission plate 8, which is comprised of glass etc. Then, regarding the vibration input pen 3, it is not limited to the above described plate wave, and for example, in the case when a surface wave that is transmitted by the vibration transmission plate 8 is used as the detected wave, it is a good option if the frequency of the vibration that is generated by the vibration input pen 3 is set to a value

that is sufficiently higher relative to the thickness of the vibration transmission plate 8 (condition where the wavelength λ of the wave that is transmitted through the vibration transmission plate 8 becomes sufficiently small relative to the thickness of the plate).

[0020]

(Explanation of the calculation performing control circuit)

After that, a detailed explanation will be provided relative to the calculation performing control circuit 1. First, if we are to explain its action schematically, the calculation performing control circuit 1 at each predetermined period (for example, every 10 seconds), outputs the start up signal for the vibrator 42 of the vibration input pen to the vibrator start up circuit 41, and together with that through its internal timer (that has a structure formed by a counter), the timing is started. Then, the vibration that is generated by the vibration input pen 3 is delayed in correspondence with the distance of the vibration input point on the top of the vibration transmission plate relative to the vibration sensors 6a ~ 6d, correspondingly, and it is transmitted.

[0021]

The signal waveform detection circuit 9 inputs the signal from each vibration detection sensor 6a ~ 6d, and through the below described waveform detection treatment, a signal is generated that indicates the timing for the vibration transmission to each of the vibration sensors, and the calculation performing control circuit 1 inputs this signals to each sensor and it detects the time for the vibration transmission to each of the vibration sensors 6a ~ 6d, and based on that the coordinates of the vibration input points are calculated. Also, the calculation performing control circuit 1 outputs the coordinate information of these calculated input points to the host computer 10.

[0022]

After that the structure and the action of the calculation performing control circuit 1 will be described in detail using the block diagram shown in Figure 3.

[0023]

In Figure 3, 31 is a micro computer that controls the calculation performing control circuit 1 and the whole body of the coordinate input device, and it has a structure that is formed from the CPU, the internal counter, the control sequence memorizing ROM, then the used for the calculations etc., RAM, the constant memorizing non volatile memory etc.

[0024]

32a ~ 32d correspond correspondingly to the vibration sensors 6a ~ 6d, and they are used for counting the reference clock that is not shown in the figure and they are timing

counters and when, to the vibrator start up circuit 41, a start signal is input in order to begin the start up of the vibrator 42 of the vibration input pen 3, this timing is started. By that, the same period of the start of the timing and the vibration detection by the sensor, is obtained, and it is possible to measure the delay until the vibration is detected by the vibration sensors 6a ~ 6d (vibration transmission timing).

[0025]

The vibration transmission timing signal that occurs in each of the vibration sensors 6a ~ 6d and that is output through the signal waveform detection circuit 9 is input into the counters 32a ~ 32d through the detection signal input circuit 34.

[0026]

Then, the received signal that is obtained from the entire vibration transmission timing signal is judged by the judging circuit 33, and when that is done its principle signal is output to the microcomputer 31. When the micro computer 31 receives the signal from the judging circuit 33, the vibration transmission timing from the counters 32a ~ 32d to the vibration sensors 6a ~ 6d is read by the chip circuit and the below described calculation is performed and the coordinates of the vibration input points on the surface of the vibration transmission plate 8, are calculated.

[0027]

Then, the calculated coordinate information, through the I/O port 35 is output to the host computer 10 and by that for example, it is possible to display a dot, etc., at a position corresponding to the vibration input position on the surface of the display 11, etc.

[0028]

(Explanation of the measurement of the vibration transmission timing)

After that, by using Figure 4 and Figure 5, an explanation will be provided regarding the measurement of the vibration transmission timing from the above described vibration input points to the vibration sensors 6a ~ 6d, and the measurement of the distance between the input point and the sensors based on the vibration transmission timing. Figure 4 is a block diagram showing the structure of the signal waveform detecting circuit 9, and Figure 5 shows the signal waveform that has been treated by each part of the signal waveform detecting circuit 9, and it is a signal waveform diagram in order to explain the measurement treatment of the vibration transmission timing based on the signal treatment. Moreover, here below, an explanation is provided regarding the case of the vibration sensor 6a, however, the content of this explanation is exactly the same for the other vibration sensors 6b ~ 6d. Regarding the circuit in Figure 4, it is also provided the same way relative to the vibration sensors 6b ~ 6d.

[0029]

As it has already been explained, the measurement of the vibration transmission timing from the vibration input point to the sensor 6a starts at the same time as the output of the start signal towards the vibrator start up circuit 41. At this time, from the vibrator start up circuit 41 to the vibrator 42, the shown according to Figure 5 start up signal 51 is applied. The start up signal 51 is for example a 2 discharge, short rectangular pulse. Through this signal 51, the vibrator 42 is started, and if the operator touches the pen tip chip 5 of the vibration input pen 3 to the desired input point on the top surface of the vibration transmission plate 8, from this input point ultrasonic wave vibrations are transmitted.

[0030]

Regarding the ultrasonic wave vibration, it is propagated for a transmission timing that corresponds to the distance from the vibration input point to the vibration sensor 6a, and after that it is detected by the vibration sensor as a short detected waveform. Regarding the reason why the start up signal 51 is made to be a short pulse it is in order to eliminate the misdetection caused by interference (stacking) of the unnecessary component that is reflected mainly by the edge surface of the vibration transmission plate 8 and to design a minimization of the whole body of the device.

[0031]

Regarding the output obtained by the detection of the vibration by the vibration sensor 6a, it is amplified through the preamplifier 401 that is shown in Figure 4. 52 in Figure 5 shows the signal waveform of this detected output. The envelope 521 of this signal waveform 52 is related to the phase position 522 and correspondingly the described below signal treatment is performed.

[0032]

First, regarding the treatment of the envelope 521, in order to eliminate the unnecessary vibration components, the signal 52 is passed through a high pass filter 402, and the signal that has passed through is processed. Namely, regarding the envelope 521 treatment, because it is easy to receive the impact of the reflected wave, the detected signal as it is short after passing through the high pass filter 402, is used only in envelope detection.

[0033]

From the detection signal after passing through the high pass filter 402, through the envelope detection circuit 403, the envelope signal 53 is yielded.

[0034]

The envelope signal 53 is input in the envelope bending point detection circuit 404 and the gate signal generating circuit 406. The gate signal generating circuit 406 reduces the

envelope signal 53 to the appropriate vibration width and on top of that a constant offset is added and a reference level signal 541 is generated. The 2-step differential output waveform 54, which is obtained as the envelope bending point detection circuit 404 has differentiated the envelope signal 53, is also input in the gate signal generating circuit 406. Regarding the gate signal generating circuit 406, by comparing the 2 step differentiated output waveform 54 and the reference level signal 541, the gate generation signal 542 is generated, and it is output to the single equilibrium multi high filter 407.

[0035]

The single equilibrium multi high filter 407 generates the predetermined pulse width gate signal 55 from the timing of the rise of the gate generation signal 542, and it is output to the tg comparator 405 and the tp comparator 411.

[0036]

Regarding the tg comparator 405, it uses the gate signal 505 and the 2 step differentiated waveform 54 as inputs, and the zero cross point at the time when the gate signal 55 is opened is used as the envelope bending point and the tg (group delay time) signal 501 is generated. The tg signal 501 is introduced in the calculation performing control circuit 1.

[0037]

On the other hand, by the treatment that is related to the phase 522 of the detected signal 52, first, the detected signal 52 is passed through a narrow band region band region passing filter 409, and it is made into a desired width frequency component signal, and then, through the slice circuit 410, the waveform is sliced down to the predetermined vibration width level (waveform level contraction). The phase signal that is the output of that and the gate signal 55 are input into the tp comparator 411. The tp comparator 411 detects the zero cross point when the predetermined turn (in Figure 5 turn 2) of the phase signal 58 at the time when the gate signal 55 is opened, rises, and the output from that phase delay timing tp signal 59 is introduced into the calculation performing control circuit 1.

[0038]

Here, in the case of the reference level signal 541, which is used in order to output the gate generation signal 541, it is also a good option if it is made to be a modified level that has the same period as the pulse of the start up signal 51 that corresponds to the distance between the vibration input pen 3 and the vibration sensor 6a, and in the case when because of the distance the modified width of the detected level is high, by using the modified level it is possible to effectively stabilize the detection point.

[0039]

Because of the fact that the vibration that is used in the device according to this practical embodiment condition is a plate wave, the relationship between the envelope 521 of the detected waveform relative to the transmission distance inside the vibration transmission plate 8and the phase 522, changes in correspondence with the transmission distance during the vibration transmission. Here, the envelope 521 propagation speed, namely, the group speed is denoted as Vg, then, the phase propagation sped, namely, phase speed is denoted as Vp. From these group speed Vg and phase speed Vp it is possible to detect the distance between the vibration input point from the vibration input pen 3 and the vibration sensor 6a.

[0040]

First, if we stick only to the envelope 521, its speed is Vg and if a point on a certain specific waveform, for example, the bending point, is detected, the distance between the vibration input point and the vibration sensor 6a is denoted as d, and its vibration transmission timing is denoted as tg, the following is obtained:

$$d = Vg \cdot tg \quad (1)$$

In the case of this equation it is related to one vibration sensor 6a, however, by performing the same, it is possible to also represent the distance between the other three vibration sensors 6b ~ 6d and the vibration input point.

[0041]

Especially, in order to define the coordinates with an even higher accuracy, a treatment is conducted based on the detection of the phase signal. From the phase delay time tp, that is detected as described earlier from the phase 522 of the detected signal 52, the distance d between the vibration sensor and the vibration input point, becomes:

$$d = n \cdot \lambda p + Vp \cdot tp \quad (2)$$

Here, λp represents the wavelength of the elastic wave, and n represents an integer number.

From the above described equations (1) and (2) the above described integer number n can be calculated according to the equation (3).

[0042]

$$n = int \, [(Vg \cdot tg - Vp \cdot tp)/ \lambda p + \tfrac{1}{2}] \quad (3)$$

Especially, as it has already been described earlier, as the detected wave a plate wave is used and because of that, it cannot be said that the linearity properties of the group delay timing relative to the distance, are good, and the practical realization of the calculation to find out the integer number according to the equation (3) is performed because of that.

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The required sufficient conditions in order to obtain an exact integer number n are shown in the following here below equation (5) that is derived from the equation (4).

$$n^* = (Vg \cdot tg - Vp \cdot tp)/ \lambda p \qquad (4)$$

$$\Delta N = n^* - n <= 0.5 \qquad (5)$$

In other words it indicates conditions where if the generated deviation amount is within +/- ½ wavelength, even if the linearity properties of the group delay timing tg are not good, it is possible to determine accurately the integer number n. The n obtained according to the above described is substituted in the equation (2) and by that it is possible to measure with a good accuracy the distance d between the vibration input point and the vibration sensor 6a.

[0044]

Moreover, the distances between the other vibration sensors 6b ~ 6d and the vibration input point can also be measured with a good accuracy by performing the same procedures.

[0045]

(Explanation of the calculation of the coordinates of the input points)

After that the calculation of the coordinates of the vibration input point based on the above described vibration transmission timing and the distance, are explained by using Figure 6 as a reference.

[0046]

Here, if the vibration sensors 6a ~ 6d are positioned, as shown in Figure 6 at the corner part areas denoted as Sa ~ Sd of the four corners of the vibration transmission plate 8, based on the above described measurement of the vibration transmission timing, it is possible to obtain the straight line distances da ~ dd from the vibration input point P of the vibration input pen 3 to the position of each of the vibration sensors 6a ~ 6d. Especially, through the calculation performing control circuit 1 and based on the straight line distances da ~ dd, the coordinates of the vibration input point P (x, y) can be calculated from the following equations (6), (7) from a square theorem.

[0047]

$$x = (da + dd) \cdot (da - dd) /2X \qquad (6)$$
$$y = (da + db) \cdot (da - db) /2Y \qquad (7)$$

Here X represents the distance between the vibration sensors 6a, 6d, Y represents the distance between the vibration sensors 6a, 6b, and from the calculations according to the

equations (6), (7), it is possible to calculate in real time the coordinates of the vibration input point P.

[0048]

Also, in the case of the above described calculation, a calculation is performed by using the information about the distances between the input point P and the three sensors, however, according to the conditions of this practical embodiment, 4 individual sensors are placed and because of that by using the distance information of the one remaining sensor, for example, it is possible to perform the detection verification of the accuracy of the output coordinates. Also, if the input point – sensor distance d becomes large, the level of the detection signal is decreased and the probability of receiving a noise effect becomes large and because of that it is also a good option if the calculation of the coordinates is performed without using the sensor distance information that has the largest distance d and it is calculated based on the remaining three sensors. Also, according to this practical embodiment condition 4 sensor units are positioned, and the coordinates are calculated based on the distance information from the three sensors, however, geometrically it is possible to have coordinate calculation based on 2 or more sensors, and it is no problem if the number of the sensors is determined according to the manufactured product specs.

[0049]

(Explanation of the Shield Structure of the vibration sensor part)

After that, the shield structure of the vibration sensor part is explained based on Figure 7 and Figure 8. Here, the shield structure of the vibration sensor 6a part is shown, however, naturally, on the other sensor parts 6b ~ 6d the same shield structure can be provided.

[0050]

In the sectional view diagram shown in Figure 7, the structure around the vibration sensor 6a is shown.

[0051]

In the case of Figure 7, 61 represents the housing body of the coordinate input device, and it covers the top part of the four-side perimeter part of the vibration transmission plate 8. Regarding the housing body 61, it is a body that is positioned at a distance from the vibration transmission plate 8 so that there is no interference with the vibration transmission that occurs in the vibration transmission plate 8, and it is positioned so that the side edge part 61a of the middle right side of the diagram of the housing body 61 is in proximity to the bent in the downward direction vibration transmission plate 8, and it is positioned so that that a gap can be opened between it and the vibration transmission plate 8 in order to not have interference on the vibration transmission.

[0052]

The shield case 62 is placed on the inner side of the housing body 61. This shield case 62 is necessary in order to prevent the mixing in of external noise into the feeble detected signal of the vibration sensor 6a. The shield case 62 is placed so that it covers and encloses the positioned on the surface of the edge part of the vibration transmission plate 8 vibration sensor 6a, anti-vibration material 7, electrode 63 and preamplifier 401, etc., and it is connected to the not shown in the diagram frame grand, or the preamplifier 401 grand. Moreover, the electrode 63 is used in order to transmit the signal detected by the vibration sensor 6a to the preamplifier 401.

[0053]

Regarding the shield case 62, the same way as in the case of the housing body 61, so that there is no interference with the vibration transmission occurring in the vibration transmission plate 8, it is at a distance from the vibration transmission plate 8, and it is positioned so that the side edge part 62a of the middle right side of the diagram of the shield case 62 is in proximity to the bent in the downward direction vibration transmission plate 8, and it is positioned so that that a gap can be opened between it and the vibration transmission plate 8 in order to not have interference on the vibration transmission. The gap between the side edge part 62 a and the vibration transmission plate 8 is connected to the gap between the side edge part 61a of the housing body 61 and the vibration transmission plate 8.

[0054]

The shield case 62 has a structure that is formed as on the front surface of the magnetized material 622 obtained as cobalt – nickel etc., strong magnetic properties possessing material has been magnetized, a plating 621 using a strong magnetic properties possessing material is conducted. Then, regarding the magnetized material 622, it is provided so that, especially, on the part of the side edge part 62a that is in the proximity of the vibration transmission plate 8, a strong magnetic field is formed. For example, the magnetized material 622 part on the side edge part 62a of the shield casing 62, as shown in the Figure 8 that is viewed from the direction of the arrow in the middle of Figure 7, it is magnetized in a magnetization pattern that is formed from a number of stripes with a predetermined width and with opposite polarity. Moreover, the metal plating 621 becomes the common path of the magnetic bundle in the space between the magnetic poles of the magnetized material 622, and it is a material used to weaken the self-demagnetization effect found in the magnetized material 622.

[0055]

Because of the fact that the shield case 62 is magnetized like that, even if from the gap that is left open between the housing body 61 and the vibration transmission plate 8, metal foreign materials enters inside the housing body 61, and then penetrates inside the shield case 62, if this metal material is a strongly magnetic material like iron etc., its

foreign material is attracted by the magnetic force of the side edge part 62a of the shield case 62, and the penetration inside the shield case 62 is prevented.

[0056]

Consequently, there is no short-circuiting of the circuits that are close to the vibration sensor 6a like the preamplifier etc., that would be caused by such foreign type materials, and naturally it is possible to eliminate the miss-operation, the lack of operation, or the fires etc., poor conditions that would be caused by such short-circuiting. Also, in order to prevent these poor conditions, it is not necessary to bury the gaps between the housing body 61, the shield case 62 and the vibration transmission plate correspondingly, and there is no interference of the housing body 61 and the shield case 62 on the vibration transmission that occurs in the vibration transmission plate 8, and because of that there is also no decrease of the accuracy of the calculation of the coordinates by the device. By doing that, it is possible to form a structure of a coordinate input device with excellent reliability properties and excellent stability properties.

[0057]

However, according to the above described practical embodiment conditions, the shield case 62 has a structure where on the magnetized material 622, namely, on a magnet, the metal plating 621, has been provided, however, it is also a good option if the structure is formed only by using a magnetized material without performing a metal plating. However, in this case, the magnet storage time is short and because of that a structure is made so that the shield case can be easily exchanged.

[0058]

Also, although the number of the assembly processes is increased, it is also a good option if the main body of the shield case 62 is formed from a strongly magnetic material that has not been magnetized, and a magnet is fixed by using a double sided tape etc., on the part corresponding to the above described side edge part 62a facing through the gap between that main body and the vibration transmission plate.

[0059]

[Results From the Present Invention]

As it is clear from the above described, according to the present invention it is a coordinate input device that has a vibration transmission plate and a vibration detection means, which is provided on a predetermined position on the above vibration transmission plate, and a vibration that is input at any input point on the above described vibration transmission plate through a vibration input device is detected through the above described vibration detection means, and based on the vibration transmission time from the input point to the vibration detection means, the coordinates of the input point are calculated; which has a structure where it has shield case formed from a strongly

magnetic material that covers the above described vibration detection means that is place don the above described vibration transmission plate and shields from the external noise, and where the above shielding case has at least one part that is magnetized, and in the case when foreign matter comprised of strongly magnetic material enters from the outside into the shield case, the above foreign matter is attracted through the above magnetic force and the penetration is prevented. And because of that structure there is no short-circuiting of the circuits that are in the vicinity of the vibration detection means caused by the penetration of foreign matter comprised of strongly magnetic material inside the shield case, and it is possible to eliminate the miss-operation, the lack of operation, the fires, etc., poor conditions that would be caused by such short-circuiting, and it is possible to improve the reliability properties and the stability properties of the device. Also, the shield case and the housing body of the coordinate input device are correspondingly positioned at a distance from the vibration transmission plate so that it is possible to open a gap between them and the vibration transmission plate, and it is possible to not have interference with the vibration transmission performed by the vibration transmission plate and it is possible to obtain the excellent results where it is said that there is no decrease of the coordinate calculation accuracy.

[Brief Explanation of the Figures]

[Figure 1]

Figure 1 represents a block diagram showing the structure of the whole body of the coordinate input device according to the practical implementation condition of the present invention.

[Figure 2]

Figure 2 represents a schematic structural diagram showing the schematic structure of the vibration input pen of the same device.

[Figure 3]

Figure 3 represents a block circuit diagram showing the structure of the calculation performing control circuit in the same device.

[Figure 4]

Figure 4 represents a block circuit diagram showing the detailed structure of the signal waveform detection circuit in the same device.

[Figure 5]

Figure 5 represents a signal waveform diagram showing the signal waveform treated by each part of the same signal waveform detection circuit.

[Figure 6]

Figure 6 represents an explanation diagram in order to explain the calculation method of the coordinate of the vibration input point according to the same device.

[Figure 7]

Figure 7 represents a schematic cross sectional view of the area in the vicinity of the vibration sensor that shows the structure of the shield on the part in the vicinity of the vibration sensor in the same device.

[Figure 8]

Figure 8 represents an explanation diagram showing one example of a magnetization pattern of the shield case in Figure 7.

[Figure 9]

Figure 9 represents a schematic diagram of the part in the vicinity of the vibration sensor in order to explain the problems of the coordinate input devices according to the previous technology.

[Explanation of the Symbols]

1.....................................calculation performing control circuit
2.....................................pen code
3.....................................vibration input pen
4.....................................internal pen circuit
5.....................................pen tip chip
6a ~ 6d..............................vibration sensors
7.....................................anti-vibration material
8.....................................vibration transmission plate
9.....................................signal waveform detection circuit
10....................................host computer
11....................................display
61....................................housing body
62....................................shield case
621...................................metal plating
622...................................magnetized material
63....................................electrode
401...................................preamplifier

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(54)【発明の名称】　座標入力装置

(57)【要約】

【課題】　超音波振動方式の座標入力装置において、外部から侵入した異物による内部の電気回路の短絡を防止する。

【解決手段】　装置の筐体61の内側にシールドケース62が設けられ、振動伝達板8上の振動センサ6a，電極63，前置増幅器401等を覆い、外来ノイズからのシールドを行う。ケース62は、磁化された強磁性体材料である磁化材622に強磁性体材料の金属メッキ621を施して構成され、特にケース62の側縁部62aに強磁場が形成されるように磁化される。外部の異物が伝達板8との隙間から筐体61内に侵入し更にケース62内に侵入しようとした場合、異物が鉄等の強磁性体であれば、磁力によりケース62の側縁部62aに吸着され、ケース62内への侵入が阻止される。従って、この異物によりケース62内の電気回路が短絡されることはない。
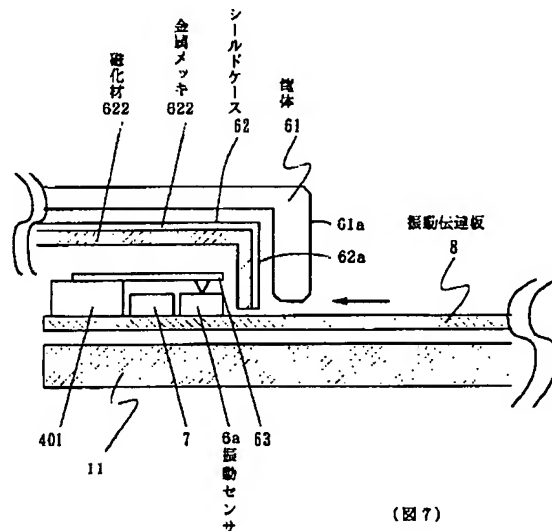
（図7）

【特許請求の範囲】
【請求項１】　振動伝達板と、該振動伝達板の所定部位に設けられた振動検出手段を有し、振動入力手段により前記振動伝達板上の任意の入力点に入力された振動を前記振動検出手段により検出し、前記入力点から振動検出手段までの振動伝達時間に基づいて入力点の座標を算出する座標入力装置において、
前記振動伝達板上で前記振動検出手段を覆い外来ノイズからのシールドを行う強磁性体からなるシールドケースを有し、
該シールドケースは、少なくとも一部が磁化されており、強磁性体からなる異物が外部からシールドケース内に侵入しようとした場合に該異物を磁力で吸着して侵入を阻止するように構成したことを特徴とする座標入力装置。
【請求項２】　座標入力装置の筐体が前記シールドケースを覆い、且つ該筐体と前記振動伝達板との間に隙間ができるように振動伝達板から離間して配置され、
更に、前記シールドケースも、該シールドケースと前記振動伝達板との間に隙間ができるように振動伝達板から離間して配置されることを特徴とする請求項１に記載の座標入力装置。
【発明の詳細な説明】
【０００１】
【発明の属する技術分野】本発明は座標入力装置に関し、特に振動入力手段により振動伝達板上の任意の入力点に入力された振動を振動伝達板の所定部位に設けられた振動検出手段により検出し、前記入力点から振動検出手段までの振動伝達時間に基づいて入力点の座標を算出する座標入力装置に関するものである。
【０００２】
【従来の技術】超音波振動により座標入力を行う座標入力装置は、例えば特公平５－６２７７１号公報で開示されているように、座標入力面を構成するタブレット（振動伝達板）に振動センサが設けられ、タブレットの座標入力面上の任意の振動入力点に入力される振動を振動センサにより検出し、入力点から振動センサまでの振動伝達時間に基づいて入力点の座標を算出する。この方式では、タブレット上にマトリックス状電線等の細工を何ら施す必要がないので、コスト的に安価な装置を提供することが可能である。しかもタブレットに透明な板ガラスを用いれば他の方式に比べて透明度の高い座標入力装置を構成することができる。この透明度の高いことを利用して、液晶表示装置と超音波振動方式の座標入力装置を重ねた構成とした入出力一体型の装置がある。この装置では表示画面に対してダイレクトに座標入力することができるので、視認性、操作性に優れており、今後の普及が見込まれる。
【０００３】
【発明が解決しようとする課題】図９は、上述した入出力一体型の装置の従来例の振動センサ周辺の構造を示す概略的な断面図である。同図において、８１は装置の筐体である。８２は座標入力操作用の振動入力ペンであり、超音波振動を発振する。８３は座標入力面を構成する振動伝達板（ガラス板）である。８４は振動伝達板８３の端部に設けられた振動センサである。８５は振動センサ８４を後段の回路に接続するための電極である。８６は液晶表示装置である。
【０００４】振動入力ペン８２の先端を振動伝達板８３の座標入力面上の任意の入力点に当接させることにより、ペン８２から発振された超音波振動がその入力点から伝達されて振動センサ８４で検出される。そして入力点から振動センサ８４までの振動伝達時間に基づいて入力点の座標が算出される。
【０００５】ところで、この装置においては、超音波振動の伝達時間と音速に基づいて入力点の座標を算出するのを基本原理としているので、振動伝達板８３内において音速が一定であることはもとより、振動センサ８４で検出される検出信号波形が常に同一形状で有ることが好ましい。このため、超音波振動の伝達径路中には振動伝達板８３以外何も介在しないのが望ましいので、図８中矢印で示すように、筐体８１と振動伝達板８３との間に隙間ができるようにし、筐体８１が振動伝達板８３の振動伝達に干渉しないようにしている。
【０００６】しかしながら、この隙間があると、外部の異物が筐体８１内に侵入しやすくなるという問題がある。特に、金属の異物が筐体８１の内部に侵入することによって、内部の電気回路を短絡させ、装置の誤動作、不動作や火災などの事故を引き起こす可能性があり、装置の信頼性、安全性に問題がある。
【０００７】そこで本発明の課題は、この種の座標入力装置において、外部から侵入した異物による装置内部の電気回路の短絡を防止し、装置の信頼性および安全性を向上することにある。
【０００８】
【課題を解決するための手段】上記の課題を解決するため、本発明によれば、振動伝達板と、該振動伝達板の所定部位に設けられた振動検出手段を有し、振動入力手段により前記振動伝達板上の任意の入力点に入力された振動を前記振動検出手段により検出し、前記入力点から振動検出手段までの振動伝達時間に基づいて入力点の座標を算出する座標入力装置において、前記振動伝達板上で前記振動検出手段を覆い外来ノイズからのシールドを行う強磁性体からなるシールドケースを有し、該シールドケースは、少なくとも一部が磁化されており、強磁性体からなる異物が外部からシールドケース内に侵入しようとした場合に該異物を磁力で吸着して侵入を阻止するように構成した。
【０００９】このような構成によれば、異物が外部からシールドケース内に侵入しようとした場合、その異物が

鉄等の強磁性体からなるものであれば、シールドケースに磁力で吸着され、その異物のシールドケース内への侵入が阻止される。したがって、その異物によってシールドケース内の振動検出手段周辺の回路が短絡されることがない。

【００１０】また、この短絡を未然に防止できるため、シールドケースと座標入力装置の筐体をそれぞれ振動伝達板との間に隙間ができるように振動伝達板から離間して配置し、振動伝達板の振動伝達に干渉しないようにすることができる。

【００１１】
【発明の実施の形態】以下、図を参照して本発明の実施の形態を説明する。

【００１２】〈座標入力装置の全体構成の説明〉まず、本発明による座標入力装置の実施形態の全体構成について、図１により説明する。

【００１３】図１において、１は演算制御回路であり、装置全体を制御するとともに、後述のように入力点の座標を算出し、その座標データをホストコンピュータ１０にシリアルケーブル等で送信する。演算制御回路１の詳細は後述する。

【００１４】２は、ペンコードであり、これを介して演算制御回路１から振動入力ペン３内のペン内部回路４に各種の信号が伝達される。振動入力ペン３の詳細は後述する。

【００１５】８はアクリルやガラス板等、透明板材からなる振動伝達板であり、その上面が座標入力面となるが、その上面には、振動伝達板８が割れたときの飛散防止のために、ＰＥＴ等からなる飛散防止フィルム（ラミネート）が粘着層を介して張り付けられている。振動入力ペン３による座標入力は、この振動伝達板８の上面をタッチすることで行う。実際には、図１中に実線で示す符号Ａの領域内を振動入力ペン３でタッチすることで行う。また、振動伝達板８の外周には、振動伝達板８の外周の端面で反射した振動が中央部に戻るのを防止（減衰）させるための防振材７が設けられている。さらに、振動伝達板８の端部の四隅のそれぞれにおいて、防振材７の境界近傍に、圧電素子等の機械的振動を電気信号に変換する振動センサ６ａ～６ｄが固定されている。

【００１６】９は信号波形検出回路であり、振動センサ６ａ～６ｄのそれぞれから入力される振動検出信号を処理して各振動センサにおける振動の到達タイミングを示す信号を生成し、演算制御回路１に出力する。

【００１７】１１は液晶表示装置等のドット単位の表示が可能なディスプレイであり、振動伝達板８の下面に重ねて配置されている。このディスプレイ１１は、ホストコンピュータ１０が出力する画像信号により、振動入力ペン３によりタッチされた入力点の位置にドットを表示する。それを透明な振動伝達板８を透してみる事が可能になっている。

【００１８】〈振動入力ペンの説明〉次に、振動入力ペン３の詳細について図２により説明する。図２に示すように、振動入力ペン３に内蔵されたペン内部回路４は、振動子駆動回路４１と振動子４２によって構成される。振動子４２の駆動信号は演算制御回路１から低レベルのパルス信号として供給され、振動子駆動回路４１によって所定のゲインで増幅された後、振動子４２に印加される。電気的な駆動信号は振動子４２によって機械的な超音波振動に変換され、ペン３のペン先チップ５を介して振動伝達板８に伝達される。なお、振動子駆動回路４２は、振動入力ペン３に内蔵せずに、座標入力装置本体側の制御基板に設けてもよい。

【００１９】振動子４２の振動周波数は、ガラスなどからなる振動伝達板８に板波を発生する事が出来る値に選択される。さらには、振動入力ペン３は、前述の板波に限定されることなく、例えば振動伝達板８を伝播する表面波を検出波として利用する場合、振動入力ペン３が発生する振動の周波数を、振動伝達板８の厚みに対して十分高い値（振動伝達板８を伝播する波の波長λが板の厚みに対して十分小さくなるような状態）に設定すれば良い。

【００２０】〈演算制御回路の説明〉次に、演算制御回路１の詳細について説明する。まず、その動作の概略を説明すると、演算制御回路１は所定周期毎（例えば１０ｍｓ毎）に振動子駆動回路４１に振動入力ペン３の振動子４２を駆動させる信号を出力すると共に、その内部タイマ（カウンタで構成されている）による計時を開始させる。そして、振動入力ペン３より発生した振動は振動センサ６ａ～６ｄのそれぞれに対して振動伝達板８上の振動入力点からの距離に応じて遅延して到達する。

【００２１】信号波形検出回路９は各振動センサ６ａ～６ｄからの信号を入力し、後述する波形検出処理により各振動センサへの振動到達タイミングを示す信号を生成するが、演算制御回路１は各センサ毎のこの信号を入力して、各々の振動センサ６ａ～６ｄまでの振動伝達時間を検出し、これに基づいて振動入力点の座標を算出する。また、演算制御回路１は、この算出された入力点の座標情報をホストコンピュータ１０に出力する。

【００２２】次に、演算制御回路１の構成および動作の詳細を図３のブロック図により説明する。

【００２３】図３において、３１は、演算制御回路１及び本座標入力装置全体を制御するマイクロコンピュータであり、ＣＰＵ、内部カウンタ、制御手順を記憶したＲＯＭ、そして計算等に使用するＲＡＭ、定数等を記憶する不揮発性メモリ等によって構成されている。

【００２４】３２ａ～３２ｄは、振動センサ６ａ～６ｄのそれぞれに対応し、不図示の基準クロックをカウントして計時するカウンタであって、振動子駆動回路４１に振動入力ペン３の振動子４２の駆動を開始させるためのスタート信号を入力すると、その計時を開始する。これ

によって、計時開始とセンサによる振動検出の同期が取られ、振動センサ６ａ～６ｄにより振動が検出されるまでの遅延時間（振動伝達時間）が測定できる。

【００２５】信号波形検出回路９より出力される各振動センサ６ａ～６ｄにおける振動到達タイミング信号は、検出信号入力回路３４を介してカウンタ３２ａ～３２ｄに入力される。

【００２６】そして全ての振動到達タイミング信号の受信がなされたことを判定回路３３が判定すると、マイクロコンピュータ３１にその旨の信号を出力する。マイクロコンピュータ３１は、この信号を判定回路３３から受信すると、カウンタ３２ａ～３２ｄから振動センサ６ａ～６ｄまでの振動伝達時間をラッチ回路より読み取り、後述する計算を行なって、振動伝達板８上の振動入力点の座標を算出する。

【００２７】そして、算出した座標情報をＩ／Ｏポート３５を介してホストコンピュータ１０に出力することにより、例えばディスプレイ１１上の振動入力点に対応する位置にドット等を表示すること等ができる。

【００２８】〈振動伝達時間計測の説明〉次に、上記の振動入力点から振動センサ６ａ～６ｄまでの振動伝達時間の計測及び振動伝達時間に基づく入力点とセンサ間の距離の測定の詳細について図４及び図５により説明する。図４は信号波形検出回路９の構成を示すブロック図であり、図５は信号波形検出回路９の各部で処理される信号波形を示し、その信号処理に基づく振動伝達時間の計測処理を説明するための信号波形図である。なお、以下、振動センサ６ａの場合について説明するが、その説明内容は他の振動センサ６ｂ～６ｄについても全く同様である。図４の回路は振動センサ６ｂ～６ｄに対しても同様に設けられている。

【００２９】既に説明したように、振動入力点から振動センサ６ａまでの振動伝達時間の計測は、振動子駆動回路４１へのスタート信号の出力と同時に開始する。この時、振動子駆動回路４１から振動子４２へは図５に示す駆動信号５１が印加される。駆動信号５１は例えば２発の短い矩形パルスである。この信号５１によって、振動子４２が駆動され、操作者が振動入力ペン３のペン先チップ５を振動伝達板８の上面の所望の入力点に当接させると、その入力点から超音波振動が伝達される。

【００３０】超音波振動は、振動入力点から振動センサ６ａまでの距離に応じた伝達時間をかけて進行した後、短い検出波形として振動センサ６ａで検出される。駆動信号５１を短いパルスとする理由は、振動伝達板８の主に端面での不要反射成分と検出すべき振動との干渉（重畳）による誤検出を防ぎ、装置全体の小型化を図るためである。

【００３１】振動センサ６ａが振動を検出した出力は図４中の前置増幅器４０１により増幅される。図５の５２は、その検出出力の信号波形を示している。この信号波

形５２のエンベロープ５２１と位相５２２に関してそれぞれ以下のように信号処理がなされる。

【００３２】まず、エンベロープ５２１の処理については、不要振動の成分を除去するために、信号５２をハイパスフィルタ４０２に通し、通過後の信号を処理する。すなわち、エンベロープ５２１の処理は、反射波の影響を受けやすいので、ハイパスフィルタ４０２通過後の短いままの検出信号をエンベロープ検出のみに利用する。

【００３３】ハイパスフィルタ４０２通過後の検出信号からエンベロープ検出回路４０３によりエンベロープ信号５３が取り出される。

【００３４】エンベロープ信号５３はエンベロープ変曲点検出回路４０４及びゲート信号生成回路４０６に入力される。ゲート信号生成回路４０６はエンベロープ信号５３を適当な振幅に減衰した上で一定のオフセットを加えた参照レベル信号５４１を生成する。ゲート信号生成回路４０６には、エンベロープ変曲点検出回路４０４がエンベロープ信号５３を２階微分した２階微分出力波形５４も入力される。ゲート信号生成回路４０６は２階微分出力波形５４と参照レベル信号５４１とを比較することでゲート生成信号５４２を生成し、単安定マルチバイブレータ４０７に出力する。

【００３５】単安定マルチバイブレータ４０７はゲート生成信号５４２の立ち上がりタイミングから所定のパルス幅のゲート信号５５を生成し、ｔｇコンパレータ４０５とｔｐコンパレータ４１１に出力する。

【００３６】ｔｇコンパレータ４０５は、ゲート信号５５と２階微分波形５４とを入力とし、ゲート信号５５が開いている間のゼロクロス点をエンベロープの変曲点としてｔｇ（群遅延時間）信号５０１を生成する。ｔｇ信号５０１は演算制御回路１に供給される。

【００３７】一方、検出信号５２の位相５２２に関する処理では、まず検出信号５２が狭帯域な帯域通過フィルタ４０９に通されて所定幅の周波数成分の信号にされ、さらにスライス回路４１０によって波形を所定の振幅レベル以下にスライス（波形のレベル圧縮）される。その出力である位相信号５８とゲート信号５５とがｔｐコンパレータ４１１に入力される。ｔｐコンパレータ４１１は、ゲート信号５５の開いている間の位相信号５８の所定の順番（図５では２番目）にあたる立ち上がりのゼロクロス点を検出し、その出力である位相遅延時間ｔｐの信号５９が演算制御回路１に供給される。

【００３８】ここで、ゲート生成信号５４２を出力するための参照レベル信号５４１は、振動入力ペン３と振動センサ６ａの距離に応じて駆動信号５１のパルスに同期した可変レベルとしてもよく、距離により検出レベルの変動幅が大きい場合は可変レベルとすることで検出点が安定するのでさらに有効である。

【００３９】本実施形態の装置で用いられている振動は板波であるため、振動伝達板８内での伝達距離に対して

検出波形のエンベロープ５２１と位相５２２の関係は振動伝達中に伝達距離に応じて変化する。ここでエンベロープ５２１の進む速度、即ち群速度をＶｇ、そして位相５２２の進む速度、即ち位相速度をＶｐとする。この群速度Ｖｇ及び位相速度Ｖｐから振動入力ペン３の振動入力点と振動センサ６ａ間の距離を検出することができる。

【００４０】まず、エンベロープ５２１にのみ着目すると、その速度はＶｇであり、ある特定の波形上の点、例えば変曲点を検出すると、振動入力点と振動センサ６ａの間の距離ｄは、その振動伝達時間をｔｇとして、

$$d = Vg \cdot tg \quad\quad （1）$$

で与えられる。この式は振動センサ６ａの一つに関する

先にも述べた様に、検出波として板波を用いているので、群遅延時間ｔｇの距離に対する線形性が良いとは言えず、式（３）において整数化を実行しているのはこのためである。正確な整数ｎを求めるための必要十分条件は次の式（４）から導出される式（５）に示される。

【００４３】

$$n^{*} = (Vg \cdot tg - Vp \cdot tp) / \lambda p \quad\quad （4）$$
$$\triangle N = n^{*} - n \leqq 0.5 \quad\quad （5）$$

つまり、発生する誤差量が±１／２波長以内であれば、群遅延時間ｔｇの線形性が良くなくても、整数ｎを正確に決定することができる事を示すものである。上記のようにしてもとめたｎを（２）式に代入することで、振動入力点と振動センサ６ａ間の距離ｄを精度良く測定することができる。

【００４４】尚、他の振動センサ６ｂ〜６ｄと振動入力

ここでＸは振動センサ６ａ，６ｄ間の距離、Ｙは振動センサ６ａ，６ｂ間の距離であり、この式（６），（７）の計算により、振動入力点Ｐの座標をリアルタイムで算出することができる。

【００４８】また、上記計算では入力点Ｐから３つのセンサまでの距離情報を用いて計算しているが、本実施形態では４個のセンサが設置されているので、残りのセンサ１個の距離情報を用いて例えば出力座標の確からしさの検証を行うことができる。また、入力点−センサ間距離ｄが大きくなると検出信号レベルが低下しノイズの影響を受ける確率が大きくなるので、距離ｄが最も大きくなったセンサの距離情報を用いず、残りのセンサ３個で座標を算出しても良い。また本実施形態では４個のセンサを配置し、３個のセンサの距離情報から座標を算出しているが、幾何学的には２個以上のセンサで座標算出が可能であり、製品スペックに応じてセンサの個数が設定されることは言うまでもない。

【００４９】〈振動センサ部のシールド構造の説明〉次に、振動センサ部のシールド構造について図７，図８に

ものであるが、同じ式により他の３つの振動センサ６ｂ〜６ｄと振動入力点の距離も同様にして表すことができる。

【００４１】更に、より高精度な座標決定をするために、位相信号の検出に基づく処理を行なう。検出信号５２の位相５２２から先述のように検出した位相遅延時間ｔｐより、振動センサと振動入力点の距離ｄは、

$$d = n \cdot \lambda p + Vp \cdot tp \quad\quad （2）$$

となる。ここでλｐは弾性波の波長、ｎは整数である。前記（１）式と（２）式から上記の整数ｎは、（３）式により求めることができる。

【００４２】

$$n = int[(Vg \cdot tg - Vp \cdot tp) / \lambda p + 1/2] \quad\quad （3）$$

点との間の距離もそれぞれ同様にして精度良く測定することができる。

【００４５】〈入力点の座標算出の説明〉次に、上記の振動伝達時間、距離の計測に基づく振動入力点の座標算出の詳細について図６により説明する。

【００４６】今、振動センサ６ａ〜６ｄを図６に示す振動伝達板８の四隅の角部近傍の符号Ｓａ〜Ｓｄの位置に設けると、上述した振動伝達時間の計測に基づいて、振動入力ペン３の振動入力点Ｐから各々の振動センサ６ａ〜６ｄの位置までの直線距離ｄａ〜ｄｄを求めることができる。更に演算制御回路１で直線距離ｄａ〜ｄｄに基づき、振動入力点Ｐの座標（ｘ，ｙ）を３平方の定理から次の式（６），（７）により求めることができる。

【００４７】

$$x = (da + dd) \cdot (da - dd) / 2X \quad\quad （6）$$
$$y = (da + db) \cdot (da - db) / 2Y \quad\quad （7）$$

より説明する。ここでは振動センサ６ａ部のシールド構造を示すが、他の振動センサ６ｂ〜６ｄ部にも同じシールド構造が設けられるのは勿論である。

【００５０】図７の断面図には振動センサ６ａ周辺の構成が示されている。

【００５１】図７において、６１は座標入力装置の筐体であり、振動伝達板８の四辺の周縁部上を覆っている。筐体６１は、振動伝達板８における振動伝達に干渉しないように、振動伝達板８から離間しており、筐体６１の図中右側の側縁部６１ａが下方に折曲されて振動伝達板８に接近しているものの、振動伝達板８との間に、振動伝達に干渉しないために必要な隙間ができるように配置されている。

【００５２】筐体６１の内側にはシールドケース６２が設けられている。このシールドケース６２は、振動センサ６ａの微弱な検出信号に外来ノイズが混入するのを防ぐために必要である。シールドケース６２は、振動伝達板８の端部上に設けられた振動センサ６ａ，防振材７，電極６３および前置増幅器４０１等を覆い、包囲するよ

うに配置されており、不図示のフレームグランド或いは前置増幅器４０１のグランドに接続される。なお電極６３は振動センサ６ａの検出信号を前置増幅器４０１に伝達するためのものである。

【００５３】シールドケース６２は、筐体６１と同様に、振動伝達板８における振動伝達に干渉しないように、振動伝達板８から離間しており、シールドケース６２の図中右側の側縁部６２ａが下方に折曲されて振動伝達板８に接近しているものの、振動伝達板８との間に、振動伝達に干渉しないために必要な隙間ができるように配置されている。側縁部６２ａと振動伝達板８の間の隙間は、筐体６１の側縁部６１ａと振動伝達板８の間の隙間に連通している。

【００５４】シールドケース６２は、コバルト・ニッケル等の強磁性体材料を磁化させた磁化材６２２の表面に強磁性体の金属メッキ６２１を施したものとして構成されている。そして、磁化材６２２は、特に振動伝達板８に接近している側縁部６２ａの部分で消磁場を形成するように設計されている。例えば、シールドケース６２の側縁部６２ａにおける磁化材６２２の部分が図７中の矢印方向から見て図８に示すように、所定幅の複数のストライプ状で交互に逆極性となる磁化パターンで磁化される。なお、金属メッキ６２１は磁化材６２２の磁極間の磁束の通路となり、磁化材６２２における自己減磁作用を弱めるためのものである。

【００５５】このようにシールドケース６２が磁化されているので、筐体６１と振動伝達板８の隙間から筐体６１内に金属の異物が侵入し、さらにシールドケース６２内へ侵入しようとしても、その金属が鉄等の強磁性体であれば、その異物がシールドケース６２の側縁部６２ａに磁力により吸着され、シールドケース６２内への侵入が阻止される。

【００５６】したがって、その異物により電極６３や前置増幅器４０１等の振動センサ６ａ周辺の回路が短絡されることがなく、その短絡による装置の誤動作、不動作、あるいは火災等の事故を未然に防ぐことができる。また、これらの事故を防ぐために筐体６１及びシールドケース６２のそれぞれと振動伝達板８の間の隙間を埋める必要がなく、筐体６１及びシールドケース６２が振動伝達板８の振動伝達に干渉しないので、装置の座標算出精度を低下させることもない。このようにして、信頼性及び安全性に優れた座標入力装置を構成することができる。

【００５７】ところで、上記の実施形態では、シールドケース６２は、磁化材６２２、すなわち磁石に金属メッキ６２１を施した構成としたが、金属メッキを施さずに磁化材のみで構成してもよい。ただし、その場合、保磁時間が短くなるので、シールドケースを簡単に交換可能な構成とする。

【００５８】また、組み立て工数が増加するが、シール

ドケース６２の本体を磁化していない強磁性体材料から形成し、この本体の振動伝達板と隙間を介して対向する上記側縁部６２ａに相当する部分に磁石を両面テープ等で固定するようにしてもよい。

【００５９】
【発明の効果】以上の説明から明らかなように、本発明によれば、振動伝達板と、該振動伝達板の所定部位に設けられた振動検出手段を有し、振動入力手段により前記振動伝達板上の任意の入力点に入力された振動を前記振動検出手段により検出し、前記入力点から振動検出手段までの振動伝達時間に基づいて入力点の座標を算出する座標入力装置において、前記振動伝達板上で前記振動検出手段を覆い外来ノイズからのシールドを行う強磁性体からなるシールドケースを有し、該シールドケースは、少なくとも一部が磁化されており、強磁性体からなる異物が外部からシールドケース内に侵入しようとした場合に該異物を磁力で吸着して侵入を阻止するように構成したので、強磁性体からなる異物がシールドケース内に侵入して振動検出手段周辺の回路を短絡することがなく、その短絡による装置の誤動作、不動作あるいは火災等の事故を未然に防止することができ、装置の信頼性及び安全性を向上させることができる。また、シールドケースと座標入力装置の筐体をそれぞれ振動伝達板との間に隙間ができるように振動伝達板から離間して配置し、振動伝達板の振動伝達に干渉しないようにすることができ、座標算出精度を低下させることがないという優れた効果が得られる。

【図面の簡単な説明】
【図１】本発明の実施形態の座標入力装置の全体構成を示すブロック図である。
【図２】同装置の振動入力ペンの概略構成を示す概略構成図である。
【図３】同装置の演算制御回路の詳細な構成を示すブロック回路図である。
【図４】同装置の信号波形検出回路の詳細な構成を示すブロック回路図である。
【図５】同信号波形検出回路の各部で処理される信号波形を示す信号波形図である。
【図６】同装置における振動入力点の座標算出方法を説明するための説明図である。
【図７】同装置における振動センサ周辺部のシールド構造を示す振動センサ周辺の概略的な断面図である。
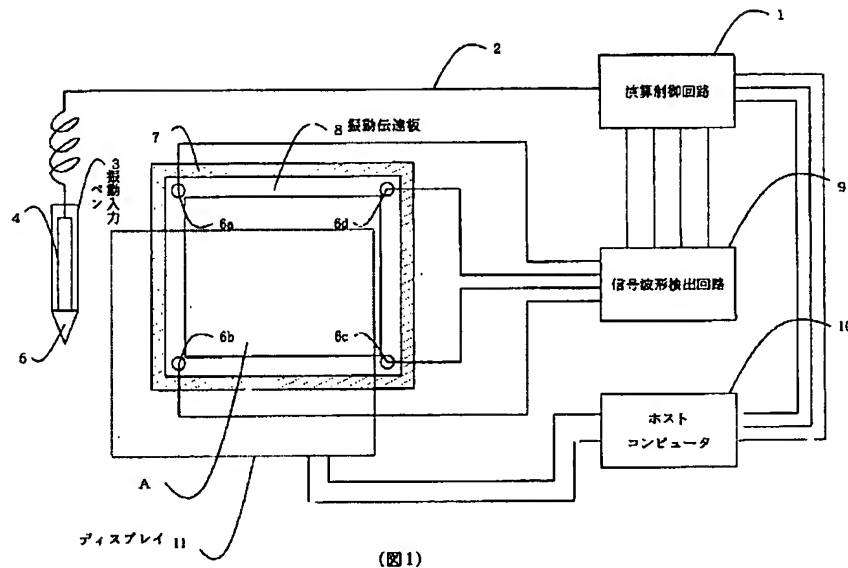【図８】図７中のシールドケースの磁化パターンの一例を示す説明図である。
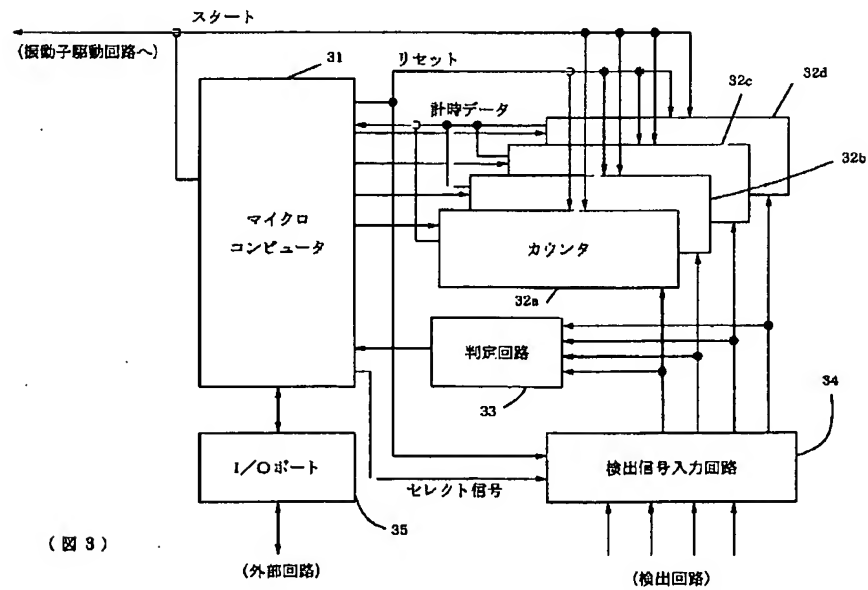【図９】従来の座標入力装置の問題点を説明するための振動センサ周辺部の概略的な断面図である。
【符号の説明】
１　演算制御回路
２　ペンコード
３　振動入力ペン

4　ペン内部回路
5　ペン先チップ
6a〜6d　振動センサ
7　防振材
8　振動伝達板
9　信号波形検出回路
10　ホストコンピュータ

11　ディスプレイ
61　筐体
62　シールドケース
621　金属メッキ
622　磁化材
63　電極
401　前置増幅器

【図1】

（図1）

【図3】

（図3）

【図2】

（図2）

【図6】

（図6）

【図4】

（図4）

【図5】

（図5）

【図7】

（図7）

【図8】
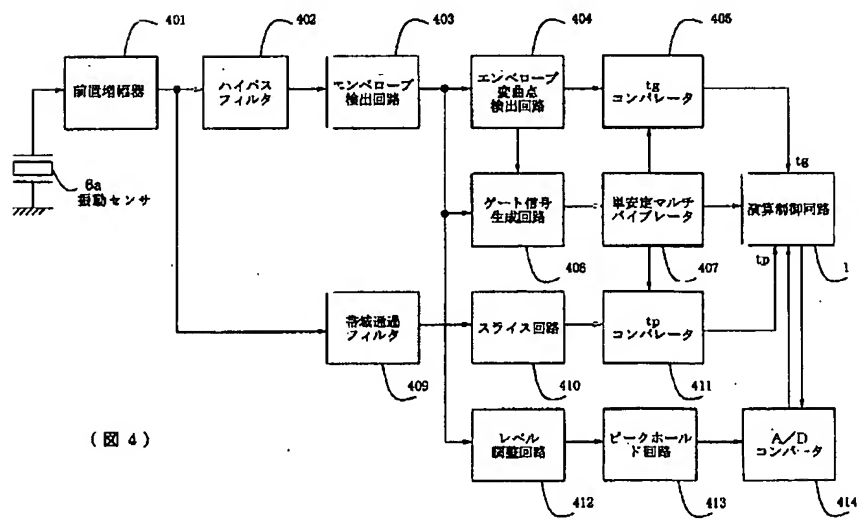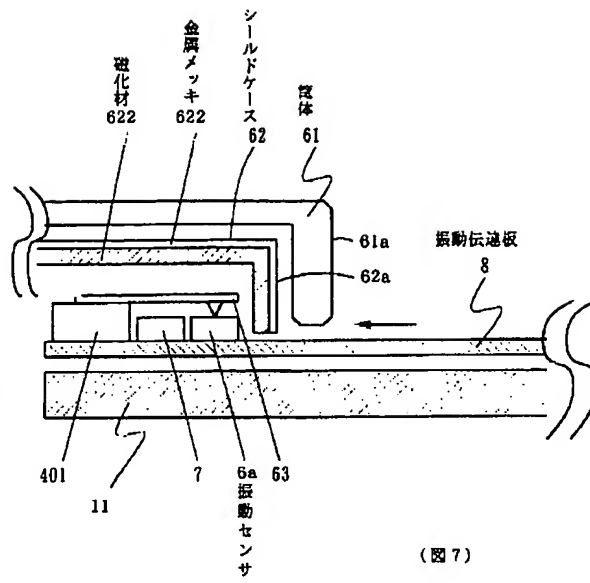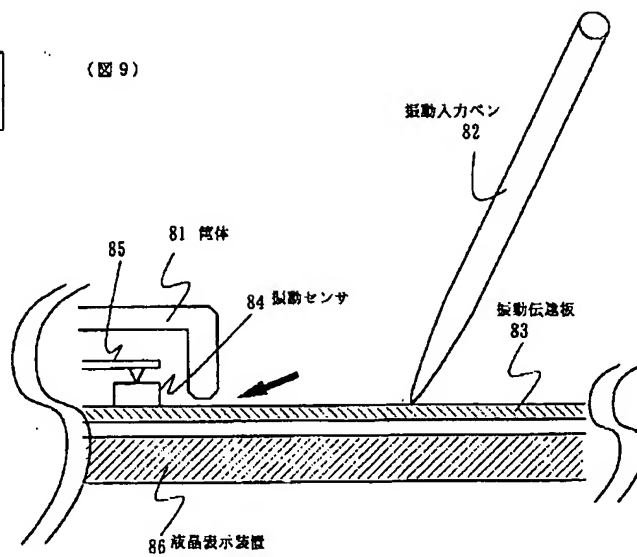

（図8）

【図9】
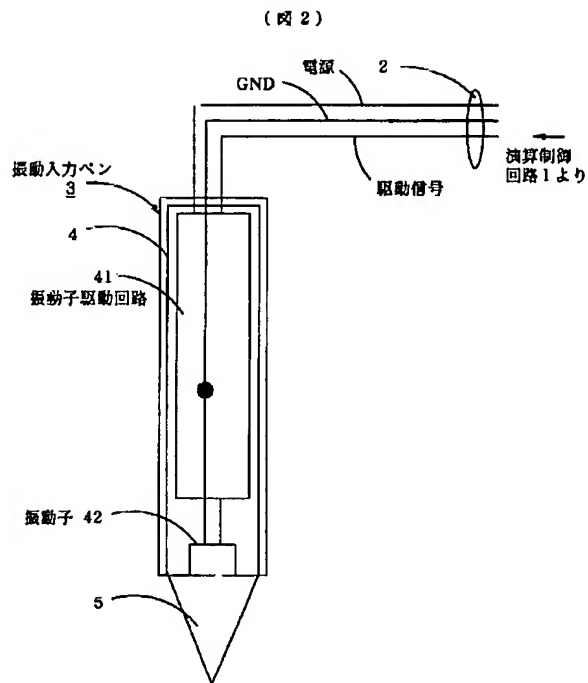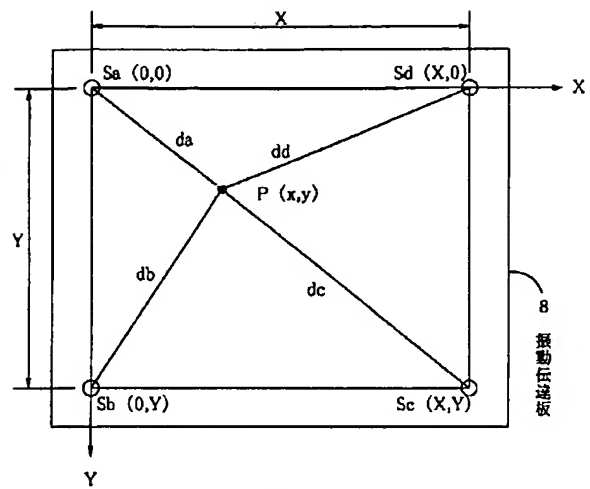
（図9）

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